Predictors of anemia in children 6-23 months in Nepal

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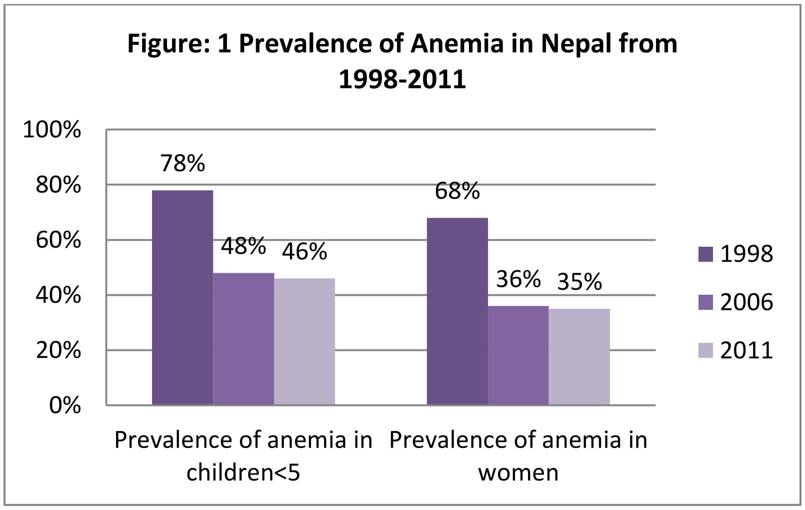
Key Messages:

- Dietary diversity is particularly poor among children aged 6-23. Using the 7 food groups outlined in the WHO Infant and Young Child Feeding guidelines, we found the mean Dietary Diversity Score (DDS) was 2.3, and only 19% of children consumed four or more food groups in the previous day.
- Children who consumed five or more food groups in the previous 24-hours were significantly less likely to be anemic than children who consumed four food groups or fewer. Consumption of eggs in particular was associated with a lower risk of anemia.
- Maternal iron supplementation during pregnancy and vitamin A supplementation for the children in the previous 6 months were not associated with anemia in children 6-23 months
- Wasting, stunting and underweight in children were not associated with an increased risk of anemia – implying the need for interventions targeting a broad population.
- Younger children, children in the Mid and Far-West terai regions, and children of anemic mothers were at an elevated risk of anemia, while being Kirat or Newari was protective against anemia.

Background

Anemia is public health burden of global concern. The World Health Organization (WHO) estimates that 1.62 billion people are affected by anemia worldwide. The situation in South East Asian Region (SEAR) is more alarming where almost 66% of preschool aged children are affected by anemia.[1] The term anemia is frequently used interchangeably with Iron Deficiency Anemia (IDA) – though only estimated 50% of the cases of anemia globally are assumed to be due to iron deficiency.[1] Iron deficiency in infancy has been shown to be associated with as poor motor functioning, cognition and school achievement, as well as behavioral problems in the middle childhood.[23] Anemia can also be caused by inadequate intae of other micronutrients including folate and vitamins A and B12, as well as by disease or genetic factors.

Anemia is a major public health concern in Nepal, particularly among women and children. According to the Nepal 2011 Demographic and Health Survey (DHS), 46 percent of Nepali children are anemic, 18 percent are moderately anemic, and less than 1 percent are severely anemic. Younger children are at an even higher risk of anemia - the national prevalence of anemia among children age 6-23 months is 69 percent.[4] Progress in reducing anemia among children in Nepal has been slow (see Figure 1). While the 1998 Nepal Micronutrient Survey implies that anemia has dropped substantially since 1998, the different methodologies for the studies make it hard to quantify true progress in reducing anemia. Furthermore, progress has been minimal in the last five years. The prevalence of anemia among children under age 5 has declined by only 2 percentage points according to the 2006 and 2011 DHS.



**1998 estimates from Nepal Micronutrient Status Survey*
*** 2006 & 2011 estimates from DHS*

While the recently published report of the DHS provides an overview of the prevalence of anemia across different stratified groups in the country, there is little analysis of the factors that may be contributing to anemia, and multivariate analyses have not yet been published with this data. Our analysis has two objectives: 1) Use multivariate analysis to determine the factors that are associated with childhood anemia in Nepal; and 2) explore whether there is an association between diet during childhood and risk of anemia.

Methods

Sampling and methods used to collect data in the 2011 DHS are presented in detail in the full report.[4] The DHS used a multi-stage stratified design intended to yield representative information for most indicators for the country as a whole, for urban and rural areas, for the three ecological zones (mountain, hill, and terai), and for each of the 13 domains obtained by cross-classifying the three ecological zones and the five development regions (Eastern, Central, Western, Mid-western, and Far-western). Due to the small population size in the Western, Mid-western and Far-western mountain sub-regions, these were combined to represent a single domain. Height and weight measurements and anemia testing was conducted in 2088 children. After limiting the sample to only those children between the ages of 6-24 months of age with complete feeding data for the previous 24 hours, the final sample is 663 children. To account for survey design, all frequencies and tabulations account for primary sampling unit, strata and probability of selection in each strata in order to yield estimates for the national level.

After assessing frequencies, we assessed the bivariate relationship of each potential predictor with anemia using logistic regression taking into account cluster and primary sampling unit. One stratum (urban mid-west hill) had to be dropped because it had only a single sampling unit, yielding a final sample of 658 children included in the bivariate regressions. All analyses were conducted in Stata/IC 11.2.

Predictors of interest included:

- Geographic variables (ecological zone, region, urban versus rural, altitude)
- Household and maternal socioeconomic variables (wealth quintile, sex of head of household, maternal education in years, religion and ethnicity)
- Maternal health and nutritional indicators (BMI, hemoglobin and anemia status, smoking status, and iron supplementation during pregnancy)
- Children's health and nutritional indicators (whether the child had suffered fever, diarrhea or cough in the last two weeks and whether the child had received vitamin A supplementation in the previous 6 months, as well as child anthropometry and feeding practices)

In bivariate analyses, child illness in the last two weeks was explored in two different ways. First we conducted three separate regressions exploring each type of illness (diarrhea, cough and fever) separately against anemia. None of the three illnesses was significantly associated with anemia. We then developed a composite indicators for illness in the past two weeks and entered this as a predictor of anemia. Still, we did not find the composite indicator for illness to be a significant predictor of anemia in the bivariate analyses. To assess the relationship between children's anthropometry and anemia, we regressed stunting (height-for-age z-score<-2SD), wasting (weight-for height z-scores<-2SD) or underweight (weight-for-age z-score<-2SD) – based on the WHO 2006 growth standards[5] against anemia.

To analyze the relationship between children's diet and anemia, a dietary diversity score was developed based on whether the child had been given foods from seven specific food groups in the day prior to the survey. The seven categories are consistent with the WHO indicators for minimum dietary diversity for breastfed infants aged 6-23 months.[6] The groups were:

1. grains, roots and tubers
2. legumes and nuts
3. dairy products (milk, yogurt, cheese)
4. flesh foods (meat, fish, poultry and liver/organ meats)
5. eggs
6. vitamin-A rich fruits and vegetables
7. other fruits and vegetables

A child was defined as having "minimal dietary diversity" if he/she consumed 4 or more food group in the previous day. The relationship between anemia and children's diet was assessed looking at each food group individually, the sum of all food groups consumed and also as a dichotomous variable assessing whether the child had consumed at least four food groups. We also assessed the relationship between anemia and breastfeeding as a dichotomous variable.

In our multivariate models we included *a priori* variables – child's sex and age which were previously demonstrated to be associated with anemia. All variables that were found to be significant predictors of anemia in the bivariate models using a significance threshold of p=0.15 were retained in the final multivariate model. In the multivariate model, all variables which were significant at the p<0.05 level in the final model are reported as significant predictors.

Results

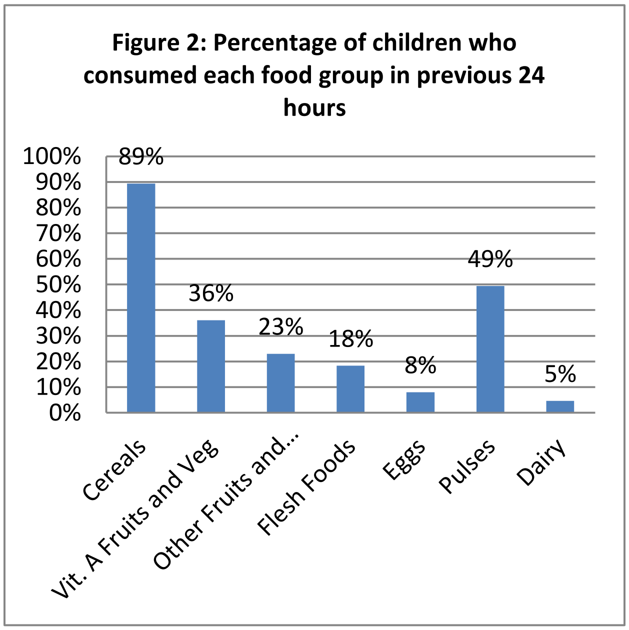
An overview of the children's demographic characteristics, health status, hemoglobin and anemia status is provided in table 1.

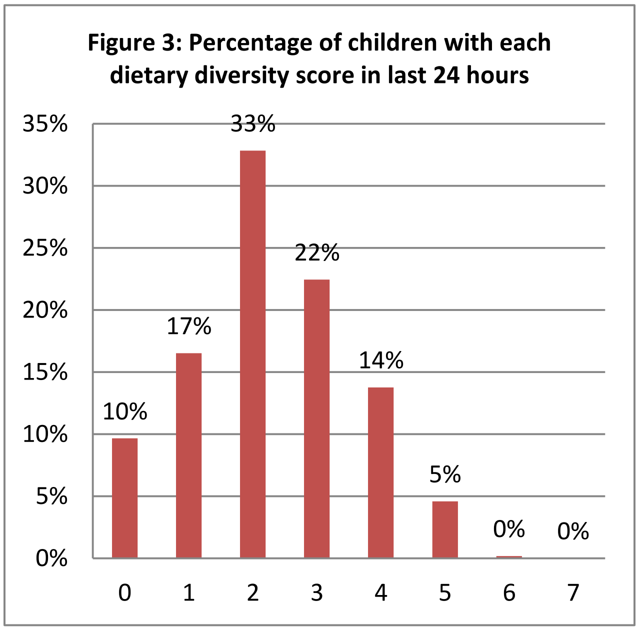
Table 1. Background Characteristics of Children 6-23 months

	Mean or %	Standard Error
Demographic Characteristics (n=664)		
Sex (percent female)	53.7%	-
Mean age (months)	14.20	0.22
Child Anthropometry		
Mean weight (kg)	8.4	0.77
Mean height (cm)	73.5	0.3
Mean weight-for-age z-score (WAZ)	-0.03	0.54
Percentage underweight (WAZ<-2SD)	32.0%	-
Mean weight-for-height z-score (WHZ)	0.40	0.54
Percentage wasted (WHZ<-2SD)	17.8%	-
Mean height-for-age z-score (HAZ)	0.01	0.54
Percentage stunted (HAZ<-2SD)	29.1%	-
Child's Health History		
had fever in last 2 weeks	28.4%	-
had diarrhea in last 2 weeks	23.9%	-
had cough in last 2 weeks	32.3%	-
received vitamin A supp. in last 6 months	76.9%	-
Hemoglobin and Anemia		
Hemoglobin	10.4	0.07
Altitude-adjusted Hemoglobin	10.3	0.06
Anemic	68.4%	-
Mildly Anemic	35.1%	-
Moderately Anemic	32.2%	-
Severely Anemic	1.1%	-

**standard errors are linearized to account for study design*

Dietary diversity was poor among children aged 6-23 months. In accordance with WHO recommendations, 96% of children in this study were currently breastfeeding; however few children were receiving the recommended diversity of complementary foods. While 89% of children received cereals, only a small fraction received animal source foods (see Figure 2). The mean number of food groups consumed was 2.3 and only 19% of children received four or more food groups in the previous day (see Figure 3). It is worth noting that these figures imply an even worse level of dietary diversity than those reported in the 2011 DHS report since the DHS disaggregated the 7 food groups into a total of 9 groups. The estimates for some of the consistent food groups are slightly different due to the fact that this sample only includes children also assessed for anemia.





In the bivariate models, month of interview, domain (combined indicator of ecological zone and region), wealth quintile, religion, ethnicity, maternal education, child's age, maternal anemia status, and the child's WAZ, HAZ and WHZ were all associated with anemia at the $p<0.15$ level. Stunting, wasting and underweight as dichotomous variables were not associated with anemia.

With regards to feeding practices, whether the child had consumed 4 or more foods the previous day was associated with anemia, as was whether the child had consumed starch staples, vitamin-A-rich plant foods, other fruits and vegetables, eggs, and pulses, legumes or nuts. Interestingly, dairy consumption and flesh food consumption on the previous day were not associated with anemia status; however, we retained these in the final model as well in order to maintain a complete picture of children's diet.

The multivariate model is displayed as Table 2. In the final model, month of assessment, religion, maternal anemia, child's age and geographical region were significantly associated with anemia. Children whose mothers were anemic had 1.74 times the risk of being anemic (95%CI: 1.16-2.63) compared to children of non-anemic mothers. Younger children were at an increased risk of anemia, as were children from the Mid-Western and Far-Western terai. Kirat children were less likely to be anemic.

Table 2: Multivariate model predicting anemia in children aged 6-23 months in Nepal

	Odds Ratio	95% CI		p-value
Month				
Baisakh (mid-April to mid-May)	1.00	-	-	-
Jestha (mid-May to mid-June)	0.39	0.20	0.78	0.008
Magh (mid-Jan to mid-Feb)	0.78	0.33	1.87	0.583
Falgun (mid-Feb to mid-March)	0.43	0.19	0.97	0.042
Chaitra (mid-March to mid-April)	0.49	0.26	0.94	0.033
Geographic Domain				
Eastern mountain	1.69	0.48	6.01	0.413
Central mountain	2.29	0.61	8.61	0.218
Western mountain	3.07	0.97	9.74	0.057
Eastern hill	1.81	0.60	5.48	0.294
Central hill	1.50	0.51	4.44	0.459
Western hill	1.00	-	-	-
Mid-western hill	1.52	0.50	4.61	0.459
Far-western hill	2.47	0.82	7.43	0.106
Eastern terai	2.92	0.90	9.51	0.075
Central terai	1.83	0.58	5.77	0.301
Western terai	1.72	0.56	5.33	0.343
Mid-western terai	4.05	1.25	13.11	0.020
Far-western terai	3.41	0.86	13.53	0.080
Wealth Quintile				
Poorest	1.48	0.61	3.60	0.381
Poorer	1.54	0.68	3.50	0.303
Middle	1.39	0.63	3.05	0.413
Richer	1.26	0.64	2.48	0.509
Richest	1.00	-	-	-
Religion				
Hindu	1.00	-	-	-
Buddhist	0.86	0.37	2.02	0.735
Muslim	1.45	0.51	4.10	0.484
Kirat	0.14	0.03	0.61	0.009
Christian	0.97	0.24	3.92	0.971
Ethnicity				
Chhetri/Brahmin	1.00	-	-	-
Dalit	1.21	0.71	2.05	0.484
Newar	0.36	0.12	1.12	0.077
Janajati	1.51	0.86	2.66	0.152
other	1.68	0.68	4.12	0.258
Maternal Education				
no education	1.58	0.87	2.85	0.133
primary	1.34	0.79	2.26	0.276
secondary	0.52	0.22	1.20	0.125
higher than secondary	1.00	-	-	-
Maternal BMI compared to normal				
Maternal BMI≤18.5	1.02	0.63	1.66	0.927
18.5<BMI<25	1.00	-	-	-
Maternal BMI≥25	0.71	0.34	1.47	0.352
Maternal Anemia (altidtude adjusted Hb<12g/dl)	1.64	1.10	2.46	0.017
Child's age (in months)	0.92	0.89	0.96	0.000
child's sex (females compared to males)	0.91	0.63	1.32	0.623

Food groups consumed in previous 24 hours				
Cereals	1.34	0.57	3.17	0.499
Vitamin A-rich Fruits and Vegetables	0.95	0.64	1.42	0.814
Other Fruits and Vegetables	1.01	0.64	1.59	0.968
Flesh foods	0.94	0.60	1.46	0.770
Eggs	0.60	0.35	1.02	0.060
Pulses	0.71	0.47	1.09	0.113
Dairy	1.72	0.76	3.89	0.191

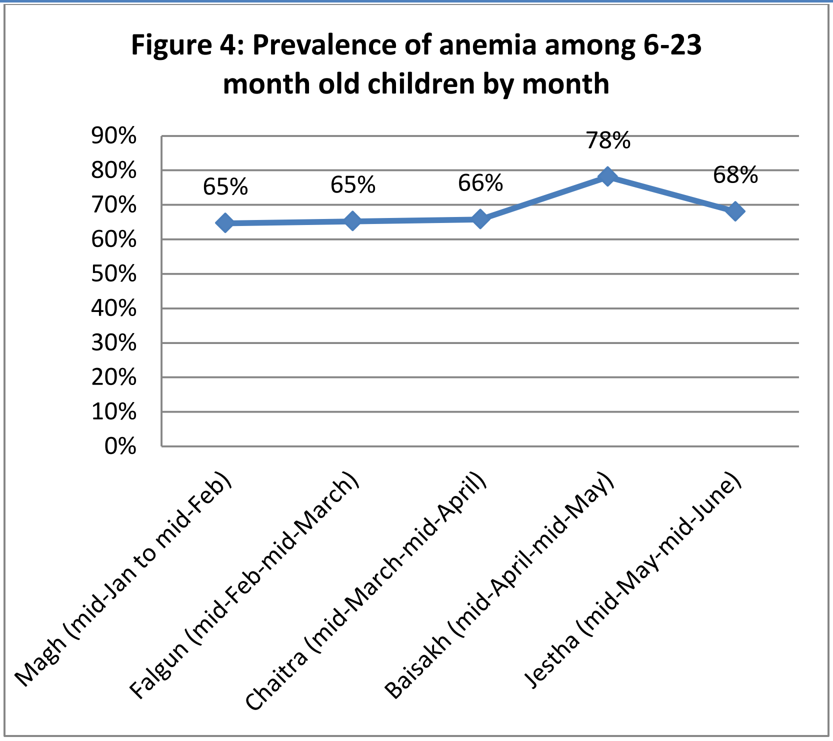
Diet and Anemia

In order to prevent colinearity between the individual food groups and the dietary diversity score, we *a priori* decided to run the multivariate model three different ways: once where the 7 food groups were entered separately, once where dietary diversity was run as a continuous variable, and once with the dichotomous variable greater than 4 foods or not. In the second two models, dietary diversity score as a continuous variable and consuming more than 4 food groups seemed to be protective against anemia; however, these estimates were not significant in the multivariate models (OR=0.91 and 0.78, p-values 0.237 and 0.275 respectively). The lack of power to detect a protective effect of dietary diversity in this population may be due to the fact that dietary diversity is so poor in this population and very few children consumed greater than four food groups (see figure 3). To further explore this issue, we created a dichotomous dietary diversity variable for children who consumed five or more food groups in the previous day. When entering this variable in the final model, we found an odds ratio of 0.35 (p=0.015, 95% CI: 0.15-0.81), implying that improving dietary diversity on the higher end of the spectrum may significantly reduce anemia burden.

In the model where the food groups were entered separately instead of as a dietary diversity score, we found that consuming eggs in the previous 24 hours was marginally significant and protective against anemia (Table 2). Children who consumed eggs in the last 24 hours had 60% of the risk of anemia compared to children who did not consume eggs. None of the other food groups were significantly associated with anemia in the multi-variate model.

Seasonality and Anemia

Month of assessment was also significantly associated with anemia. The highest prevalence of anemia in children (78%) was found during Baisakh (mid-April to mid-May), which occurs at the end of the lean season. In the following month, anemia prevalence reduced, but remained higher than earlier in the year. Figure 4 reflects the unadjusted prevalence of anemia by month. Children assessed during Jestha (mid-May to mid-June) had 0.39 times the odds (95%CI 0.20-0.78) of anemia compared to children assessed in Baisakh, while children assessed in Chaitra (mid-March to mid-April) had 0.54 (95%CI: 0.29-0.99) the odds of anemia compared to Baisakh. It is worth pointing out that the DHS is a cross-sectional survey, and the measurements of anemia were conducted in different children across the different months, so one cannot directly infer that the lean season causes anemia. DHS also only assessed hemoglobin over a 5-month period; however, the data does suggest seasonal trends in the pattern of anemia.



Discussion and policy implications:

The strongest predictors of anemia in children 6-23 months were month of assessment, religion, maternal anemia, child's age and geographical region. Interestingly, none of the anthropometric indicators of undernutrition - stunting, wasting or underweight – were associated with anemia in children in the bivariate models. This highlights the need for interventions targeting a broad population in order to address anemia and other micronutrient deficiencies, since micronutrient deficiencies are not limited only to children who display growth faltering. It is also worth noting that we did not find vitamin A supplementation in the previous 6 months or maternal iron supplementation during pregnancy to be significant predictors of anemia in the bivariate models, implying that these interventions are insufficient to prevent anemia in children ages 6-23 months in Nepal. Iron fortification and supplementation may be a more appropriate way to prevent anemia in this population. Unfortunately, we found that only 3.2% of children were taking iron supplements or consuming any micronutrient powder.

Promoting dietary diversification could also help prevent anemia. Our findings showed that dietary diversity was unacceptably poor in this population; however, children who consumed five or more food groups in the previous day were significantly less likely to be anemic than children consuming four groups or fewer. In addition, egg consumption in particular seems to be protective against anemia. Eggs contain a small amount of iron, but are also sources for other nutrients including vitamin A and B12. Similar findings on the association between eggs and anemia in children were found in Indonesia[7] - further adding support to programs that promote the consumption of animal-source foods.

Ethnicity and religion are also strong predictors of anemia – likely due to different dietary patterns. Many religious and ethnic groups in Nepal are vegetarian; however, we found that Newari and Kirat children are much less likely to be anemic than other groups; and both groups known to consume relatively higher quantities of meat. Geography was also an important predictor of anemia. Children in the Mid-Western and Far-Western terai had 3-4 times the risk of being anemic. The prevalence of anemia was also found to be higher in these in the bivariate areas. Although these areas are relatively food secure, other factors such as poverty and inappropriate dietary diversity - particularly the lack of consumption of animal source foods – may explain this trend.

Finally, it is worth highlighting that children whose mothers were anemic had 1.74 times the risk of being anemic themselves compared to children of non-anemic mothers. The mechanism for this association could be due to the amount of maternal iron passed to the child or it could be due to correlated dietary patterns and health-related behaviors. Regardless of which mechanism, this finding implies that interventions targeting anemia in mothers should link nutritional messages and supplementation programs to prevent anemia in their children as well. We also found that younger children were at an increased risk of anemia compared to older children – likely due to poor iron stores at birth and the fact that younger children are much less likely to receive diverse diets than older children because of cultural beliefs about the inability of young children to digest certain micronutrient-rich foods like eggs and meat. This highlights the need to continue to promote iron consumption in pregnancy and also dietary diversity particularly among young children.

Conclusion

In summary, the prevalence of anemia in children 6-23 months is alarmingly high (68%). Although 84% of mothers reported taking iron supplements while pregnant, only a 3% of children consume iron supplements or micronutrient powders. Supplementation or fortification could prevent the anemia burden in young children. At the same time, dietary diversity among young children in Nepal is also quite poor. Promoting dietary diversity, especially the consumption of eggs and other animal-source foods, could be an effective method for controlling anemia in this population.

Funding

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